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COVER: *Three women spinning yarn at Chincheros; woman seated at left with a backstrap loom,* illustration for "A Study of Andean Spinning in the Cuzco Region" by Miss Grace Goodell. Photograph by Alan R. Sawyer.

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HANDSPUN YARN PRODUCTION RATES IN THE CUZCO REGION OF PERU

Junius B. Bird

Originally, it was intended to combine the technical yarn data presented below with the accompanying article by Miss Grace Goodell. However, on second thought it seemed pointless to modify so very readable and informative a record by adding an analysis that could just as well be presented separately. The samples collected by Miss Goodell provide us with the first accurate figures on the rate of drop spindle yarn production ever obtained in Peru, or, for that matter, anywhere in the Americas. The figures by themselves can be misleading, for the amount of fiber a spinner can twist in a short interval of time does not necessarily provide an index of the quantity of yarn that can be produced in a day, or a week, or a longer period. The process involves too many variables, such as the ultimate function of the yarns, whether they are fine or coarse, even or uneven, their angle of twist, and the skill, experience, age, health, diligence, and motivation of the spinners. Actual yarn production is accomplished along with other duties: the shearing and preparation of the wool, household chores, weaving, planting, harvesting, child-bearing—all the activities of the spinners' lives. The important figure is the amount of yarn created in a full yearly cycle. Given such statistics as are obtainable from the samples, plus the gross yearly production or the quantity prepared for some specific purpose, one can, with reasonable accuracy, determine the number of hours spent in spinning during the course of a year or for a specific fabric.

A quite pertinent question is, why bother with such an inquiry? Is there any point in knowing what production rates may be? When I suggested that these samples be collected, it was simply to have some information where none existed. I also wanted to know if it were possible to use such data to evaluate, at least in part, the labor involved in creating textiles.

Spinning and fabric production in Peru have a long history. The record, starting more than 4500 years ago, is one which will, in large part, be recovered by archeology. It can in part be drawn from historic sources, and will be clarified by the study of contemporary products and practices.

It is difficult for most of us today to visualize the role textiles have played in this region. For a thousand years prior to the appearance of pottery in the last half of the second millennium B.C., textiles seem to have been the major art medium. Even after other media were employed, textiles were important. In time, as more techniques were utilized, as the production of wool and cotton increased, and as the dyeing process was perfected, many of the textiles were truly remarkable, both artistically and technically. Before the time of the Spanish conquest, textiles had become a measure of national wealth; they were collected as taxes, as contributions and gifts, were used in ceremonial sacrifices, and distributed as clothing for officials and for the armies.

Although specialists concentrated on various aspects of fabric production, it was, by and large, a family craft, a part of everyone's life, one understood by all, and a source of pride to the talented and industrious. In some parts of the Andean area, it is still a family craft, still a source of pride, with traditions and practices directly derived from the past. But this is an era of change and with the passing of each year there are fewer and fewer people who wear the old garments, fewer who spin, and fewer who weave. Soon it will be impossible to duplicate such yarn samples as Miss Goodell collected.

From her report it is clear that she obtained more than just data on the rate of yarn production. Her inquiry about a simple task yielded information on "lloq'e", the magical yarn, and how it is used. With this came insight into the religious thinking and practices of the people she dealt with, a reward beyond the planned objective of the study. I hope her experience will encourage others to similar endeavor.

In checking the collected yarn samples, the first move was to measure their lengths. This is not as simple as may appear, for nearly all the yarns are quite resilient, so that their measured length will vary with the tension applied. This raises a question; should one stretch them just short of the breaking point or should they be allowed to lie without tension? Obviously the latter procedure was unwise, because most of the yarns have enough twist tension to make them kink and double. The solution, although not scientifically precise, was to secure one end to one of two large pins spaced one meter apart and to pass the yarn, turn by turn, about them, using just enough tension to eliminate kinks and twists. To minimize personal variables all the samples were measured by the same person, Mrs. John Tishman. When spot checks of the lengths were made by others who followed the same rule, the figures obtained vary by only a few centimeters.

Accurate weighing of the yarns, too, poses problems for wool and hair are hygroscopic; consequently, weight will change with varying humidity. To obtain very exact figures one would need standardized humidity control; we simply stored them together and worked under relatively constant conditions. The weight fluctuations noted were not sufficient to modify the average figures by more than a few hundredths of a gram at the most.

The yarns collected fall into four categories:

1. S spun, single ply, wool yarns (lloq'e)
2. Z spun, single ply, wool yarns
3. Z spun, single ply, cotton yarns
4. Z spun, S-doubled wool yarns

Miss Goodell did not notice that the spinning twist in four of the samples was S, so she did not ask why this was being done. In one instance the decision to spin the magical S-twist yarn must have been made just after the test began, because we found that the first 40 centimeters have a Z twist. While we were handling the yarn the fibers separated at the point where the reverse occurred, probably the place where it had been attached to the spindle shaft by a half hitch. Perhaps the spinner decided to take no chances with the charming *gringa* who asked questions about things any normal person should have learned in childhood.

Curiously, one of the S-twist yarns, measuring 24.46 meters, is the longest of all the samples made in ten minutes of spinning. Another S-twist yarn is the shortest, measuring only 2.42 meters. The lengths of Z-spun woolen singles range from 23.02 to 3.21 meters. We do not know if the shorter lengths were the best the spinners could produce, or if they were the result of self-consciousness or embarrassment at the time of the test. Only one length measured less than four meters; only three are less than five meters long. In all the samples the lengths must be considered together with the weights, because the relation of length to weight gives some indication of yarn size. With small samples such as these, I have calculated the weights of ten-meter lengths, which gives us a basis for comparison.

TABLE I

Lengths, Weights, and Angle of Twist in Yarn Samples

	Groups			
	1	2	3	4
Number of samples	4	88	1	7
Twist direction	\	/	/	Λ
Maximum length, in meters	24.46	23.02	12.54	20.49
Weight, in grams	2.70	2.64	0.60	3.99
Weight per 10-meter lengths	1.105	1.149	0.475	1.945
Twist angle,* degrees	30	30/35	40	40
Minimum length, in meters	2.42	3.21	—	4.38
Weight, in grams	0.55	1.374	—	0.84
Weight per 10-meter lengths	2.264	4.275	—	1.915
Twist angle,* degrees	30	50/55	—	15
Average length, in meters	9.46	10.41	—	14.24
Average weight, in grams	1.332	2.055	—	4.140
Average weight per 10-meter lengths	1.678	1.974	—	2.906
Maximum twist angle, degrees	45	50/55	—	45
Minimum twist angle, degrees	15	15	—	15

*The acute angle between the slant of the fibers and the long axis of the yarn.

In single yarns the angle of twist is the acute angle between the slant of the fibers and the long axis of the yarn. For the two-ply yarns it is the lay of the strands. If one has a recticule protractor mounted within the ocular of a microscope, one can, with practice, make reasonably reliable readings. However, with handspun yarns I question the value of the information.

In this case I did measure all samples, even though I did not know the intended function of each yarn. The range of measurements of the Z-spun wool singles is shown in Figure 5. Within each yarn the angle is fairly consistent; variations occur at those places where the work may have been interrupted or a new roving added.

One of the two-ply yarns has a very slack doubling twist of fifteen degrees; three have a twist of forty degrees, and two of forty-five degrees. The latter seems to be the maximum twist that can be achieved by the local method and equipment as additional twisting only puts kinks in the yarn. Kinking or creping in the single yarns seems to start when the angle approaches thirty-five degrees.

Spinners who plan to produce a very hard-twist yarn sometimes re-spin or add twist to it. Miss Goodell did not encounter anyone adding twist during her survey so that we have no data on it. Anyone observing this work should collect samples of the yarn before and after the twist has been added.

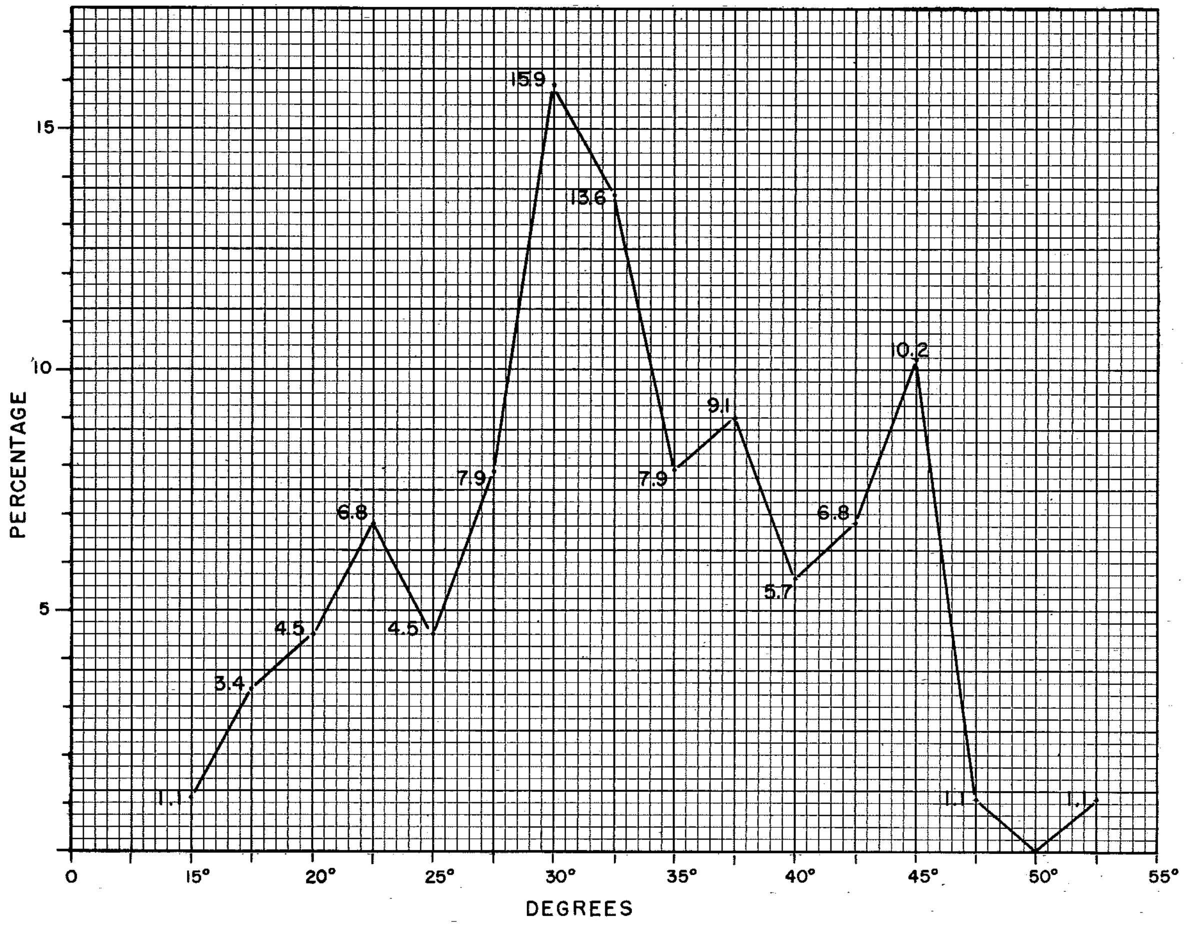

Fig. 5 *Occurrence of spinning twist angles as recorded for 88 Z spun, woolen, single yarns. Because of variations within any one yarn, measurements at best are approximate and were recorded at 2.5 degree intervals.*

When dealing with two-ply yarns it must be remembered that the overall length decreases in relation to the degree or angle of the twist. One can measure the lengths of strands before and after plying and in this way determine how much single-strand yarn is needed to produce a given amount of two-ply yarn of a specific twist range. In the absence of such figures, we untwisted a measured length of two-ply yarn similar to the average two-ply yarn used in ponchos and found that the length was reduced by ten per cent during doubling. To make ten meters of such a two-ply yarn, twenty-two meters of the single yarn are needed.

To supplement the tabulated information on the yarns, I have plotted the frequency distribution of the calculated weights of ten-meter lengths of the samples (Figure 6). Undoubtedly there is some relation between the function of the fabrics for which they were intended and these figures. I believe it would be possible to determine this without much difficulty by studying the various types of fabrics produced in the region.

Unfortunately, with such statistical treatment of data, one loses contact with the people involved. The six-year old girl, who spun steadily for only seven minutes, produced three and a half meters of soft alpaca wool yarn; a rate of five meters every ten minutes. While the fibers were irregularly drafted, the yarn is as well made as some other samples in the lot. Twelve spinners produced less than six meters; four among them were slower than the little girl, one producing only 2.42 meters of yarn. The longest sample, a rather fine, fairly even, S-spun yarn, was spun by a girl judged to be about ten years old. Another girl, perhaps twelve, spun 18.39 meters. These figures are not surprising. The girls learn and start to spin early; the sensitivity of touch and dexterity of young fingers decreases with age and the hard work to which their hands are subjected.

Out of curiosity, with no conviction that the results would be meaningful, I have applied some of the yarn production figures to a completed garment, a fine, warp-patterned woolen poncho (Figure 7),

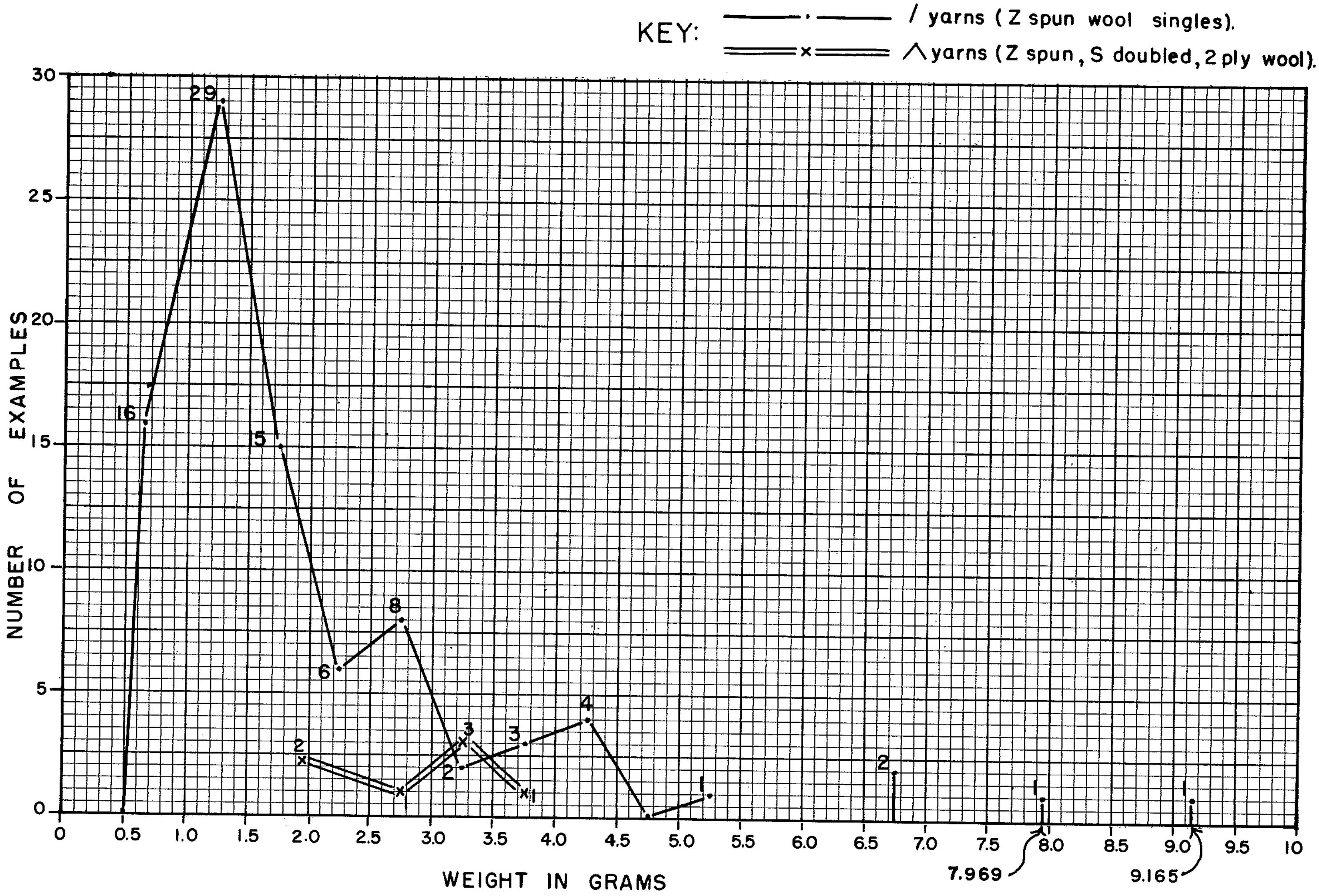

Fig. 6 *Counts of Z spun, wool, single and plied yarns as they occur within the indicated weight range as calculated for ten meter lengths.*

bought in Chahuaytiri where some of the yarn samples were obtained. Even if the poncho was not made in this community, it is certainly from some other place in the heights above Pisac. It is a type commonly known as a "Pisac" poncho, although little weaving of this particular quality is done there. The poncho is composed of two separately woven panels more or less equal in dimension; each panel has five warp-pattern "payllay" stripes, consisting mainly of alternating red and white warps. Interspersed between the pattern stripes are narrow, warp-faced, plain weave stripes of combinations of red, orange-red, pink, black and white. Each panel has four finished selvages. The weaving was not started at one end of the warp and terminated at the opposite end, but, as with most fabrics of the area, the position of the loom was reversed during the work. The final weft insertion, done with needles, is within the body of the fabric. In one panel the last pick of weft is 14 cm. from one end; in the other, 18 cm. In both, the weaver continued to create the patterns in each stripe up to the last weft and achieved an excellent and pleasing juncture, although not perfect in terms of the overall pattern flow (Figure 8). Not many modern weavers can or will take the time and trouble to create pattern in this area of terminal construction, so that one can use the feature as a measure of the quality of the weaver's work.

After the two panels described above were seamed together and the corners turned in, a separately-woven fringed edging, with uncut fringe 15 cm. long, was sewn to the margin of the neck slit and the outer border. The complete garment weighs 1183 grams. The total length of yarn, within reasonable limits, was determined by counting all warps and all wefts in the panels, by using average figures in the fringe, and by applying the figures to

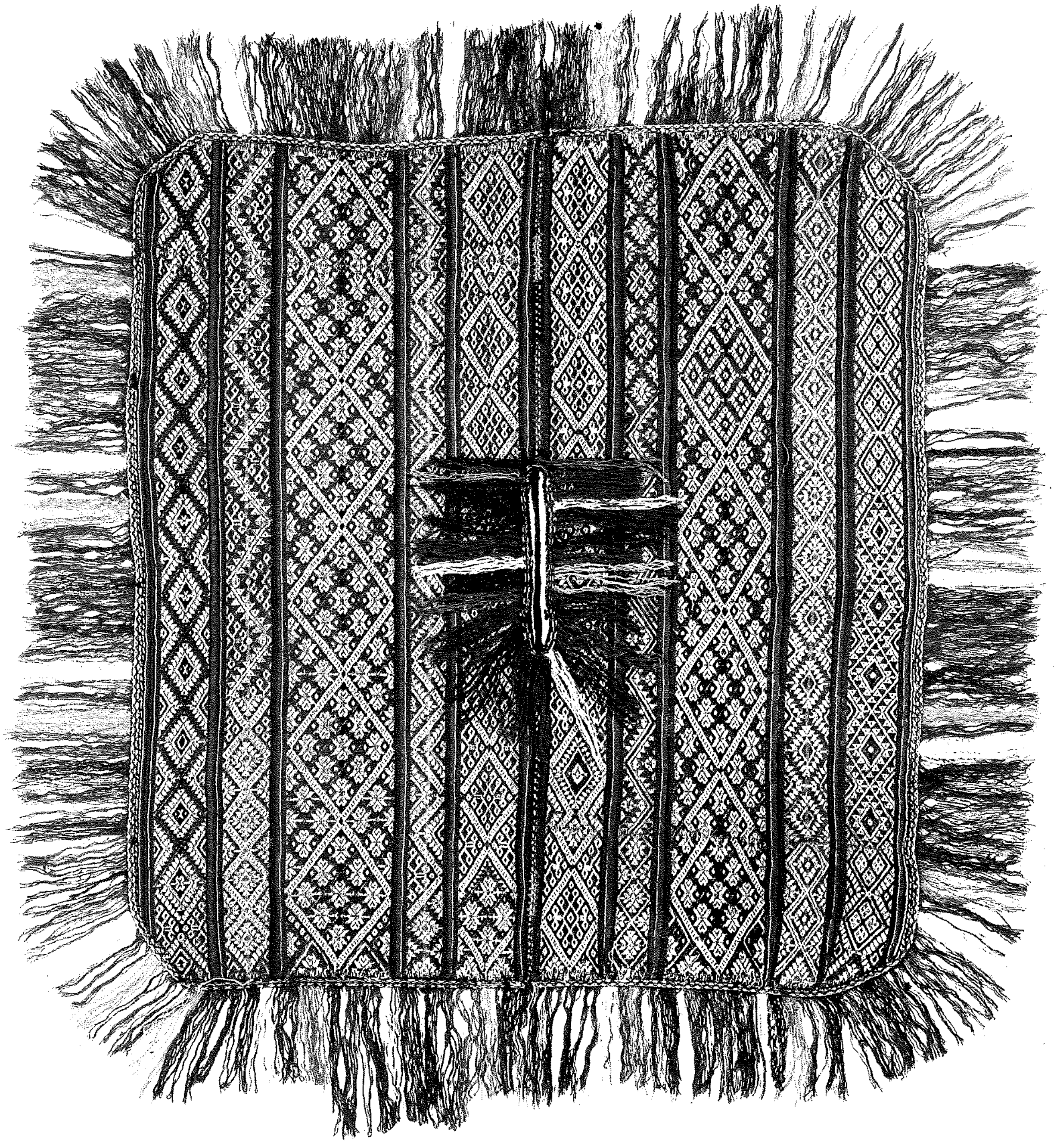

Fig. 7 *Pisac-type woolen poncho purchased in Chahuaytiri, Peru. Note design variations within the warp patterned stripes. The seeming gaps in the fringe are where white yarns failed to register in the photograph. Overall length: 140 cm.*

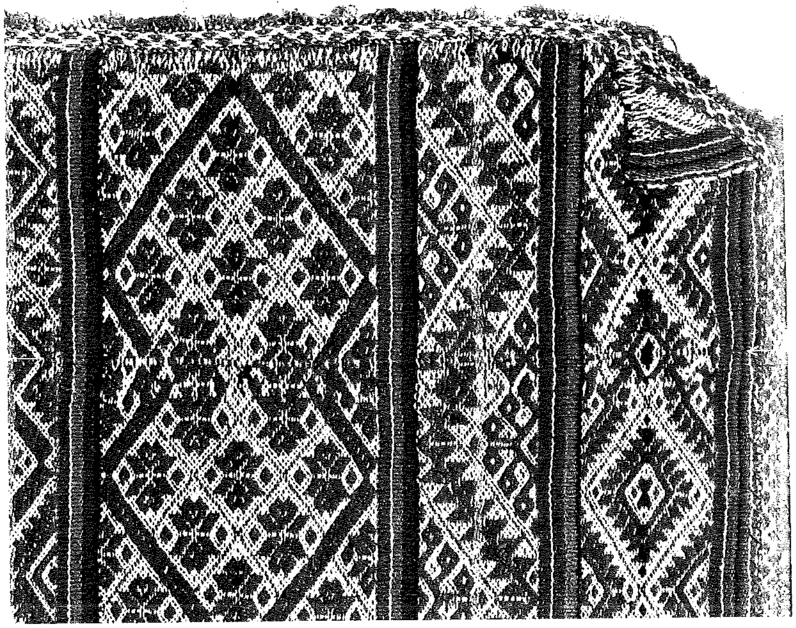

Fig. 8 *Detail of Figure 7, reverse side, showing area of terminal construction. Marginal arrow indicates final pick of weft.*

the relevant dimensions. There is some question as to how much the warp length was reduced by weft insertion. I have assumed this reduction to have been about ten per cent. The minimum length of the two-ply yarn can be readily determined; in this case it is 4858.5 meters. The addition of ten per cent of the warp length yields an approximate maximum of 5187.9 meters. From these figures and the weight of the poncho, the average weight of ten meters of the two-ply yarn is 2.438 grams at the most; 1.964 grams at the least. Similarly, allowing for a ten per cent reduction in length during doubling, the minimum amount of single-strand Z-spun yarn is 10,688.6 meters, the maximum is 11,413.5 meters. The average weight of ten meters of the single yarn should fall between 0.893 and 1.109 grams. In comparison with our yarn samples, these are within the range of the majority of the single Z-spun yarns, 68 per cent of which weigh less than two grams per ten meters.

We can estimate the time needed to spin this quantity of yarn by referring to our yarn sample records. Eighty spinners, whose yarns weighed under four grams per ten meters (average 1.667 grams), produced an average of 10.31 meters in ten minutes. At this rate the minimum amount of yarn in the poncho would require 172.8 hours of spinning; the maximum, 184.5 hours. To this we must add the doubling time necessary to convert the single strand to two-ply yarn. Six of our samples of two-ply yarn were made at the rate of 15.89 meters per ten minutes. The seventh, abnormally short, can be ignored; it was made in a market by a woman distracted by heckling and comments from onlookers. At the rate mentioned, the doubling of the yarn took between 50.9 and 54.4 hours.

Another major time-consuming part of the labor required for the poncho was the creation of the designs as the weft was inserted. Fortunately, when Miss Goodell encountered weavers at work on Pisac-type ponchos, she timed the insertion of two successive passages of the weft. The two passages involved the use of both the heddle and shed rod in addition to finger manipulation of the pattern warps. In no instance were any pattern heddles used. As her field notes include pertinent comments as well as figures, they warrant quoting:

1. "Professional weaver; weaving in courtyard where she had to stop occasionally to tend baby and burro. She considered the morning an exceptionally quiet one, with few distractions. Cuyo Grande. 24 minutes."
2. "Professional weaver; is paid two sheep for weaving a poncho. Has not woven for several years, because there is no demand. Near Cuyo Grande. 30 minutes."
3. "Professional weaver; who reported having woven over thirty pieces in her life (she enumerated each as I counted). No distractions; wove for about half an hour without looking up. Somewhere beyond Cuyo Grande. 25 minutes."
4. "Non-professional weaver; who weaves only for her family needs, but had been persuaded to do one fine poncho for a friend. Weaves only between harvest and planting time. Near Chahuaytiri. 35 minutes."
5. "Professional weaver; had to cook at the same time she wove, thus had some distractions. Very fond of weaving, but reported that she now does little as it pays poorly, i.e., two sheep for one's time. Near Chahuaytiri. 40 minutes."
6. "Non-professional weaver; wept when I inquired about the rich pattern she was working on.

She said her husband is ashamed of having a person in the house who will be associated with such reactionary styles. He wears the solid-colored or plain-striped ponchos, indicating that one has higher status, in imitation of those worn by the hacendados. She was sure this would be her last patterned poncho. Near Chahuaytiri. 27 minutes."

7. "A very sensitive artist, non-professional weaver; also very sad because, since the road has come through, people refuse to wear the beautiful old patterned weaving, preferring solid-color types which she says she does not like to do. Wove with considerable courtyard distractions. Pampallacta. 38 minutes."

8. "Young professional weaver who learned to weave with 60 warps in pattern stripes, but devised her own system of weaving with 120 warps, and takes great pride in her work. She showed me several pieces she had done, all somewhat different. As she wove she tended two babies, the chickens, the boiling pot. Pampallacta. 18 minutes."

Again, there are unknown variables. We do not know the number of warps in the pattern rows, the relative complexity of the patterns, and the skill of the weavers, all of which naturally effect the time necessary for the weft passage. However, each weaver observed was working on an adult-sized poncho panel, all with pattern areas bounded by narrow, plain stripes. The average time is so close to thirty minutes that we can safely apply that figure to our Pisac poncho. In this poncho the total count of weft picks between the end headings in the two panels is 1122. At fifteen minutes each 280.5 hours were needed for weft insertion, excluding the extra time required in the areas of terminal construction.

Miss Goodell had only one opportunity to time the warping procedure for this type of poncho. In that instance two skilled weavers, working together, prepared the warp for a second panel in two hours, fifteen minutes. Taking four and a half as the minimum for both sections, the score of hours of labor at this point is as follows:

	Hours	
	Minimum	Maximum
Spinning of yarn	172.78	184.50
Doubling of yarn	50.97	54.41
Insertion of weft	280.5	280.5
Warping	4.5	4.5
Shearing	?	?
Preparation of wool	?	?
Dyeing of yarn	?	?
Securing of warp to loom bars	?	?
Insertion of heddle lacing	?	?
Manufacture of fringed edging	?	?
Final assembly sewing	?	?
Total hours needed	508.75 +?	523.91 +?

Some of the steps for which we have no figures, such as the attachment of loom bars and heddle, are made quite rapidly. For the others we have no meaningful figures and know only that some are time consuming.

The warping time must vary because it demands concentrated attention. The yarn turns are counted for each half of the patterned stripes, and pattern and background yarn must alternate regularly. Numbers must be remembered if the warping of the opposing stripes in the separately-created sections are to match. Also, there must be some specific relationship between the proposed pattern and the numbers of warps needed. Yarn counts in the plain and patterned stripes show minor variations; yet, despite these variations, there are exactly 1185 pattern warps in each half of this poncho even though the patterns created do not match precisely.

In addition to the calculations needed for the patterns, the weaver must judge the length of unwoven warp correctly if the finished product is to have the desired length. We do not have any information on the rules followed for this part of the procedure, nor precisely the amount of reduction in warp length in the course of weaving. Other aspects of the work that require skill and intelligence, as well as time, are similarly undocumented.

It is, of course, impossible to verify our figures by consulting the spinners and weavers. They keep no records and know only the overall picture. Miss Goodell reports:

> "The weavers whom I interviewed usually estimated that it took them about six months, never less than three months, to weave a solid 'payllay', Pisac-type poncho. This always meant weaving, while at the same time fulfilling the responsibilities of the household, including helping with the farming when necessary."

The latter statement is true even of those individuals who can be classified as professional weavers, that is, those women who will contract to produce a poncho for a fee. When such an agreement is made, the standard price is two sheep, sometimes three, exclusive of the yarn which must be supplied.

Finished ponchos of this type now sell for the equivalent of fifteen to thirty dollars. Some of them from the Pisac and Paucartambo areas are brought to Cuzco by shy, handsome, young men who come to sell the single poncho their wives have woven during the year. The round trip on foot may take as long as ten days, so that the total time expended per family seems to be entirely out of proportion to the income.

With such a low return, probably averaging less than three cents an hour, it is surprising that work of any quality at all still appears. One would like to think that for the weavers there is some satisfaction, some pleasure of accomplishment. When the products, like these ponchos, are of untailored, uncut fabrics, woven to the size needed for a particular function, there is a possible personal relationship to the task that does not exist when one is producing long lengths of material on mechanical or semi-mechanical looms. Each product from the native loom is a single problem, with clear limits. At each step you can measure what has already been accomplished and what lies ahead. Now half the needed yarn is ready, now there is enough. What is in your mind in regard to color combination and distribution is fixed at the time of warping. With the warp on the loom, you work within the strict limits of the four margins. There is a beginning and an end. This is an aspect of the backstrap or comparable loom products that has not had due recognition. It is one that is lost when the products are measured by the yard and the cloth is tailored for use.

In her field report, Miss Goodell evaluates the present attitude toward weaving. One wishes that equally perceptive observers might have assessed the situation as it existed in Peru before the disruption of the Inca, and the subsequent Spanish conquest. She states:

> "Weaving is, to the artist among the weavers, still a pleasure. One woman expressed the relaxing outlet she feels in weaving, as a change from her work demands, and as a challenge. Weavers have a sense of humor and of achievement about their work, and often take pride in it. But weaving is, in most communities in the highlands, a necessity. For this reason it is rare to find a weaver willing to weave for contract. Most weavers consider it one of the necessary chores in life and enjoy it no more than the American housewife enjoys stacking her dishwasher or taking clothes to the cleaners. It has to be done, one weaver said, and this is the way you do it. Most Indians wear the native garments they have woven, not out of preference, but out of conservatism and timidity. So most weavers work to clothe themselves and their families, not to create. As in any similar craft, there are both artists and practitioners, and the latter are in the majority.
>
> "The romantic notion of the exuberance of native craftsmen needs tempering by a realistic view of the difficult life of the puña. Weaving centers are clusters of miserable mud huts in cold altiplano regions where potatoes are the meager but only staple in life, and where weaving, quite simply, clothes man to protect him from the elements."

DR. JUNIUS B. BIRD, Curator of South American Archaelogy at the American Museum of Natural History and Trustee of the Textile Museum, is already familiar to our readers as the author of the museum's Catalogue Raisonné, "Paracas Fabrics and Nazca Needlework" (with technical analysis by the late Louisa Bellinger), published in 1954. Dr. Bird is foremost among archaeologists working in the Central Andean area in his utilization of ancient textiles as archaeological documents. In 1941 while excavating one of the earliest habitation sites on the North Chilean Coast, he recovered the first fully documented stratigraphic series of ancient textiles to be obtained in South America. Later, he carried out extensive excavations on Peru's North Coast at a pre-ceramic site called Huaca Prieta, near the mouth of the Chicama Valley, where he again encountered fabrics. Although his final detailed report on this important work is still in preparation, preliminary publications of his findings have greatly contributed to our understanding of the earliest textile achievements of Ancient America. Some of the Huaca Prieta textiles dating from 2500 to 2000 B.C. bear elaborate designs and as such are the earliest known decorated textiles from Peru. Dr. Bird was able to reconstruct these patterns by carefully charting the warp movements in the twined construction of the fragments of cloth he recovered. His ingenuity, patience and thoroughness in the analysis of archaeological materials have set a new high standard in the profession.

Dr. Bird is the author of many articles on early textiles and techniques, and other archaeological subjects. He was co-author with Wendell C. Bennett of "Andean Culture History," a handbook of the American Museum of Natural History, published in 1949, and revised by Dr. Bird in 1960. The individuals he has assisted and encouraged professionally are legion. Among those greatly in his debt are the Textile Museum's Director, Alan R. Sawyer; its former Curator of Western Hemisphere Textiles, Dr. Mary Elizabeth King, and Miss Irene Emery, Curator of Technical Studies, all of whom have greatly benefited from his collaboration and advice.